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**The F/A-18 Hornet
and the
Natonal Defense Industrial Base
by
Commander Joe D. Watson, Jr., SC, USN**

ABSTRACT

As the Twenty-first century approaches, the United States finds itself in the unique position of being the world's only remaining military superpower. However, the need to maintain a military force capable of fighting and winning a global war has become questionable. Additionally, the nation is faced with the very real challenge of a weak economy, unacceptably high unemployment, a massive national debt fed by growing annual budget deficits and a deteriorating defense industrial base. In response to both the state of the economy and the lack of a discernable enemy, the Defense Department faces significant funding reductions for the foreseeable future. This situation places in jeopardy the defense industrial base as it will cause many firms to abandon defense work as being unprofitable. In order to protect the defense industrial base and ensure that a sufficient number of commercial enterprises are available to produce needed systems, the Defense Department must consider revising its traditional approach to weapon system acquisition and allow greater private participation in the depot maintenance of those systems. This should be done even at the risk of abandoning major segments of the Defense organic depot maintenance.

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The F/A-18 Hornet and the National Defense Industrial Base

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NATIONAL DEFENSE INDUSTRIAL BASE
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INTRODUCTION

The Department of Defense faces a significantly reduced resource base in support of national defense into the Twenty-first century. The consequences of this appear to be:

- There will be fewer acquisitions of new weapon systems and fewer suppliers of those systems.
- Weapon systems currently in the DoD inventory, as well as new systems, will be expected to remain in operational use longer than originally planned.
- Greater emphasis will be placed on maintenance and repair of weapon systems, especially at the depot maintenance level.
- Fewer defense dollars will also result in greater competition for those dollars between commercial and organic activities.

Until very recently, Defense Department program managers have, rightfully, concerned themselves less with the larger issue of the condition of the national economy than with developing and deploying the most capable combat systems possible. Budgetary considerations were important, often critical, but the availability of a sufficient number of companies, both at the prime and subcontractor levels, ensured that the needs of the military would be met. Further, until 1991, the Defense Department could point to a powerful threat to the nation's security, in the form of the Soviet Union, as clear justification for its budgetary requirements, and the need to maintain technological preeminence over a numerically superior adversary.

With the disintegration of the Soviet Union and the Warsaw Pact, the need to maintain a large, standing military establishment may no longer be necessary for the survival of the nation. Indeed, the current condition of the economy, with annual federal deficits approaching \$300 billion and a national debt already exceeding \$2 trillion, and growing, annual interest payments on that debt surpassing \$200 billion and unemployment sticking at between 7.3% and 7.5%, mitigates against the continuation of large annual defense budgets. The question now becomes one of sufficiency:

How do we maintain technological and qualitative superiority while dramatically reducing the defense budget? and

How can the defense portion of the national industrial base be maintained at a sufficient level to support a necessarily smaller defense establishment?

Lower defense budgets and fewer procurements mean that greater reliance will be placed on the logistics and maintenance support of existing systems rather than developing and fielding new ones. Therefore, every decision relating to weapon system logistics support must balance the resulting impact of that decision not only on the weapon system itself, but, also, on the maintenance of a viable defense industrial base.

The Navy's F/A-18 Hornet offers what I believe to be an excellent example of the dilemma facing the Defense Department as it attempts to address the dual issues of maintaining a viable defense industrial base and ensuring technologically superior weapon systems into the next century. The dilemma, simply, is how to alter the department's traditional acquisition strategies to meet new economic realities. In this paper, I will:

- briefly review the history of the Hornet with emphasis on maintenance support planning during its acquisition. This will entail some analysis of the traditional weapon system acquisition decision-making and management processes which will lead to an understanding of the current depot

maintenance structure for the Hornet.

-define the National Defense Industrial Base (NDIB) and examine the impact of the current economic and political environment on it. In so doing, I will address the results of decisions made during the "traditional" program management process concerning the depot maintenance of the F/A-18 on the NDIB.

-recommend a course of action that ensures long-term weapon system support and the maintenance of the NDIB.

History of The F/A-18 Hornet

The history of the F/A-18 is one which lends itself to a discussion and analysis of the importance of maintenance and logistics planning in the fielding of a major weapon system. While it is not the purpose of this paper to present all of the issues related to the logistics support of this weapon system, much less a complete history of the program itself, it will be useful to, briefly, review what the F/A-18 was bought to do and the relationship between the maintenance planning of that system, and the national defense industrial base.

The F/A-18 Hornet is the Navy's newest and most versatile combat aircraft.

It combines a superior air-to-air dogfighting capability with an equally excellent air-to-ground attack capability. The airplane provides, in, basically, a single airframe, significant flexibility in its various configurations. This flexibility allows for its use in a wide range of operations. Currently the F/A-18 is flown off all of the Navy's active aircraft carriers, by all Marine Corps Air Wings and by the Naval Air Reserve. In addition, the Hornet is the primary air defense and ground support aircraft of the air forces of Canada, Australia, Spain and Kuwait, with Switzerland expected to begin similar operations in 1994. There are, currently, over 1200 F/A-18's in operation worldwide, with anticipated deliveries expected to top 1500 by the end of the decade. In fact, there is an effort on the part of Senator Sam Nunn (D., Ga) to require the U. S. Air Force to acquire the Hornet for its follow-on to that service's current light-weight, "low-end" fighter/attack aircraft, the F-16.

The F/A-18 was designed, not only to be a multi-role weapon system, but one which could switch from one mission role to another, with relative ease, at the squadron level. This versatility meant that the Hornet required a minimum of hands on maintenance at the organizational and intermediate maintenance levels. Conceptually, this decision necessitated the movement away from the traditional three-tiered maintenance concept (organizational, intermediate, depot) to one more closely resembling a two-tiered, O-to-D (organizational-to-depot) concept. The impact of this has led to the need to provide a greater number of repairable components than spare parts at the squadron/AIMD level, and a greater reliance on

remote site, depot-level repair of critical subsystems.

Program Management and the Decision-Making Process

The Hornet was a significant technological advancement for the Navy and, as such, it has been an expensive aircraft. When one includes the research and development expenses, each F/A-18 costs about \$30 million. This is a far cry from what was to have been a low-cost, lightweight platform. However, the true cost of any weapon system lies not in the negotiated price of the system itself but, rather, in the logistics support bought to maintain that system throughout its operational life. These costs are incurred throughout the life of the system, but they are planned for and projected long before the first aircraft is delivered. All too often concerns for the technical costs of the program dominate concerns for the economic costs to the nation. This was no less true for the Hornet.

It is understandable why concerns for technical costs dominated. As with any system, the most significant part of the logistics planning process for the Hornet was the development and implementation of the maintenance plan under which the weapon system was to be supported throughout its life. The implementation of the maintenance plan generated the bulk of what I refer to as the technical costs of the program. Furthermore, it was from that maintenance plan that, essentially, all other logistics planning and costs sprang.

The DoD Logistics Support Analysis (LSA) Process

Although maintenance planning was the key to the successful deployment of the F/A-18, it was, nonetheless, a subset of a larger analytical process-Logistic Support Analysis. Logistics support analysis requires the performance of several tasks, many of which are performed simultaneously. Basically, the LSA provided a structured methodology whereby data was developed upon which, ultimately, resource allocation decisions could be based. The integration of the maintenance planning process into the LSA occurred at several points, and it was from the results of this integration that the maintenance concept was verified, updated and coordinated with other logistics support concepts. Most of these integration activities were performed in the early stages of the acquisition process in order to ensure that all subsequent logistic support decisions, those associated with the actual support of the fielded weapon system, could be made. The final result of the intensive systems engineering activities associated with the maintenance planning and logistic support analysis processes was a final, or master, maintenance plan used to identify all of the resources necessary to ensure that the Hornet could be maintained at the required operational availability throughout its life.

Beyond the identification of maintenance requirements, decisions were made

throughout the acquisition process concerning costs and cost trade-offs that were required to gain optimum performance within imposed budgetary constraints.

While neither logistic support analysis nor maintenance planning directly addressed cost factors, they provided the necessary information from which cost data could be derived. Essentially, the Program Manager had to balance schedule, performance and cost in such a way as to optimize all three while meeting operational requirements established by the warfighting customer/user. This would have been impossible without the data and information generated through the logistics support and maintenance planning processes.

The Maintenance Planning Process

Maintenance planning, in the Navy and throughout the Defense Department, is a disciplined, iterative activity which is designed to clearly define how a weapon system will be kept operational for its intended mission requirements throughout its anticipated lifetime. Initially, the maintenance planning process involves the determination of what type of maintenance is to be performed at each level of the maintenance hierarchy.

For the Hornet, there were three levels of maintenance considered for all repairable systems-organizational, intermediate and depot. As the planning process progressed, each individual item within the system was assigned to one of the

three levels of repair.¹

Since maintenance, by itself, could not correct inherent deficiencies or improve the reliability of the system design, it is necessary that design deficiencies be identified and corrected early as such they would, invariably, affect maintenance planning and resource procurement and provisioning decisions.

It has been a major desire on the part of the Navy in the procurement of weapon systems to place maintenance of components, assemblies and subsystems at the lowest organizational possible, consistent with least cost considerations. Thus, emphasis was placed on detailed engineering analysis, directed, primarily, at preventive maintenance actions. These measures were necessary to maximize operational availability and, consequently, minimize system downtime for corrective repair.

Part of the Hornet's engineering analysis involved a Level of Repair Analysis (LORA), another iterative process upon which least life-cycle cost to repair or discard decisions were made. LORA provided the capability to determine the logistics cost of various repair alternatives and an auditable basis for making maintenance logistics cost trade-off decisions. The LORA was conducted on the Hornet from preliminary design to final hardware configuration design and provided critical information which allowed the Program Manager cost-effective level-of-

repair decisions.²

The entire maintenance planning process was a long, involved and complicated systems engineering effort resulting in significant system life cycle cost decisions. The maintenance planning effort, while iterative, provided a composite of individual analyses through which the Hornet's design was continuously assessed (at least until final design freeze) with regards to maintenance requirements and resource planning. It was through this assessment process that key system design assumptions were either verified, revised, modified or discarded.³

The critical element in fielding a fully operational weapon system is the establishment of a fully responsive maintenance plan. Part of this process is the determination of the optimum maintenance to be performed at each organizational level. The result is a plan that phases the introduction of maintenance capabilities over time, from the initial reliance on full contractor maintenance support to the resourcing and stand up of organic maintenance. This process happens in a phased manner in order to coincide with the introduction of the weapon system. The determination of the schedule for the transition from contractor maintenance support to full organic support is critical and is influenced by several factors. These include:

- The design stability of the weapon system.
- The anticipated leadtimes for the critical elements of the maintenance and logistics plan, such as support equipment, spares, technical publications.
- The status and levels of warranty support to be provided by the contractor.
- Costs associated with, either, the acceleration or the slow down of support deployment.
- The existing capabilities of both commercial and organic maintenance organizations and the level of resourcing necessary to enhance their support capabilities.

Additional factors may include the following:

- The ability of the contractor to provide the requisite range of logistics support from initial system introduction until all logistics elements to be provided organically are available.
- The range and level of interim contractor support necessary to ensure operational availability of the weapon system until organic support is brought

on-line.

-The ultimate level of organic support to be developed and deployed and the timing of its introduction.

Major Issues Facing Program Managers

Beyond these factors, which may be viewed as, essentially, programmatic in nature, are the broader issues which must be considered, if not directly by the program office then certainly by the service acquisition executive and, ultimately, by the Secretary of Defense. These issues relate not merely to the internal consistencies of the program management effort but, also, to externalities which impact on the introduction of the system. These externalities may be seen as additional challenges to be dealt with by both the program office and the Defense Department in determining whether or not the weapon system can be fully supported. These issues include, but are certainly not limited to:

-The pace of technological advances which lead to equipment obsolescence. Questions of modularity of the system design, the relationship of software to hardware, the introduction of systemic upgrades and the planning and phasing in of modifications all necessitate a sensitivity to the direction associated technology is

taking and if that technology is capable of meeting the operational requirements of the system or, conversely, if the weapon system is adequately designed to take advantage of technological advances. Additionally, there is the issue of where and how to properly and effectively insert technology advances-at the user level by providing ready-to-use, "plug-in" assemblies, components and sub-components to the user at either the organizational (or squadron) level, the intermediate maintenance level, or at the depot level for introduction and installation during either scheduled overhaul periods.

-A defense industrial base which is showing every indication of deteriorating at an alarming pace. This issue relates not only to the ability of prime contractors to provide complete weapon systems but, equally importantly, to the availability of the sub-tier of subcontractors and parts manufacturers to feed into the prime contractors. As defense dollars disappear, the industrial base supporting defense requirements will also disappear or at least refocus itself on a commercial business base which may not easily translate into an ability to respond to defense related requirements. The consequences are obvious in that a deteriorating defense industrial base significantly reduces the number of options available to acquisition executives with which to provide adequate logistics support for fielded weapon systems. Jacques Gansler goes so far as to state:

"At the prime contractor level, the defense industry shows definite signs of a sick industry. The firms operate in a weakening market with heavy debt, difficulty in borrowing, considerable excess capacity, low cash generation, high (and growing) risk, old production equipment, too little capital investment, relatively low productivity, mixed quality and rapidly rising prices."⁴

-To offset the potential adverse impact of a reduced capability by commercial industrial concerns to provide sufficient weapon systems support, the Program Manager must give consideration to resourcing and utilizing service organic depot capabilities. With limited, and declining, resource availability, should existing depots, such as the six Naval Aviation Depots (NADEPs), be considered the preferred alternative to the commercial defense industrial base? Indeed, it has been pointed out that there is considerable redundancy between organic and commercial capabilities, particularly in the specific area of repair and overhaul of primary systems and subsystems.⁵

Clearly, the above considerations go to the heart of the issues facing the Defense Department as it views weapon systems support requirements against the backdrop of a diminishing industrial base.

The Defense Industrial Base. A Strategic Asset

The national defense industrial base (NDIB), also known as the defense technological and industrial base (DTIB), is a critical strategic asset which is comprised of both commercial enterprises and Defense Department maintenance activities. Prime contractors, such as McDonnell Douglas and Northrop, employ large numbers of people and support extensive networks of subcontractors and parts manufacturers. By contrast, the Navy organic aviation depots employ a relatively small number of people and are supported by a limited number of commercial activities.

The importance NDIB was highlighted by the Secretary of Defense in his 1992 annual defense report. In that report, he stated that the DoD interests in the NDIB "focus on the capacity of industry to produce goods and services needed to meet DoD missions and requirements."⁶ The report goes on to cite two primary points of interest, namely:

- "...the timely restoration of war reserve stockpiles" depleted as the result of DoD crises response;" and

- " ...continued modernization efforts in order to maintain highly capable equipment and weapons systems."⁷

The Office of Technology Assessment of the U.S. Congress identifies the functions

of the NDIB similarly in its 1991 publication, Redesigning Defense, as being:

- "...developing, procuring and supporting military systems in peacetime;"
- "...responding to increased military requirements in crisis and war."⁸

The OTA publication defines the NDIB (referred to as the DTIB) as being:

"...the combination of people institutions, technological know-how, and facilities used to design, develop, manufacture, and maintain the weapons and supporting equipment needed to meet U.S. national security objectives."⁹

Consequently, as the publication points out, the NDIB consists of three components: research and development, production, and repair and maintenance, each supported by prime contractors, sub-contractors, and parts manufacturers.

In determining weapon system support requirements, the Defense Department must determine the ability of the nation's industrial sector to respond to surge requirements and to provide ongoing logistics and manufacturing support to current weapons systems as well as those procured in the future. The nation

cannot afford to lose the capabilities of firms such as McDonnell Douglas and Northrop. One way to insure their continued existence is to include them in the long-term maintenance support of the systems that we buy from them.

The Navy procured the F/A-18 Hornet from McDonnell Douglas. But the involvement of that company in the Hornet's maintenance program, especially at the depot level, has diminished. The Navy intends that its involvement will cease altogether in the near future.

Programmatic decisions are driven by technical considerations relating to engineering analyses rather than by the concerns for the future of the national defense industrial base. I suggest that the program manager should more extensively use private industry to provide system life cycle maintenance support.

A Solution to the Dilemma

My concern is with that part of the NDIB that deals with the maintenance and repair of weapons systems. The vast majority of current maintenance and repair work for all services is done by organic or service depots. Depot level repair involves the overhaul of weapons systems and does not include the manufacture of weapons.

The Defense Department's organic aviation depot system supports thousands of firms, including repair facilities and original equipment manufacturers as well as engineering contractors. Many of these facilities also support the prime contractors. These depots employ approximately 50,000 civilians nationwide. The organic depot system faces the same personnel reductions as the rest of DoD in the coming years since it will not be necessary to operate depots at current levels to maintain the reduced number of weapons systems. However, the reduction in weapon systems procurement has an unexpected effect on depot maintenance and service. Because of the reduced likelihood of replacement, the services will have to maintain their current weapon systems for longer than originally planned. Service and maintenance thus will increase in importance. Therefore, even though the weapon systems and the depot personnel servicing those systems are being reduced, it is important to maintain an adequate personnel level to handle the increased maintenance requirement. In addition, complex aging weapon systems will need maintenance that is different from that which is currently provided by the depots. In the future, depots must provide a more sophisticated and technologically advanced level of service.

The transformation of the organic depot maintenance system will, of necessity, be accomplished at the expense of the nation's manufacturing base. With the services buying fewer weapon systems, the nation faces the very real possibility of losing the production capability for those weapons systems if the

prime contractors are forced to close their facilities because of the loss of sales. Without some sort of replacement in their revenues, these firms will need substantial government investment to recover quickly to meet any future surge requirements. In my opinion, it is more important and, possibly, more economical in the long run, to maintain the weapon systems manufacturing base than it is to maintain the inservice depot system as currently structured. I advocate increasing the use of private sector firms in the depot maintenance and repair of weapons systems as a means to maintain the nation's manufacturing base.¹⁰ Specifically, I advocate that these private sector firms should participate in the maintenance of the weapons systems that they have manufactured. This participation will allow these firms to maintain at least the profitability of some segments of their business and keep them in the NDIB.

It is unclear exactly how the downsizing of the Department of Defense will impact the defense industrial base. What is necessary, is to recognize the nature of the NDIB, and to understand its relationship, both directly and indirectly, to the larger national industrial base, and to national security strategy.

Summary and Conclusions

As defined above, the NDIB clearly encompasses a wide and diverse segment of the economy of the nation and has become "an indistinguishable part

of our national industrial base which, in turn, is part of an increasingly global industrial base."¹¹ There is a mutual interest between the NDIB and weapon system acquisition, each relying on the other for support. As the Defense budget decreases over the next few years, the impact each new procurement has on the NDIB will be substantial. As new weapon systems acquisitions decrease, the percentage of the national industrial base accounted for by the NDIB will decrease. With fewer and fewer prime contractors vying for fewer and fewer new systems, decisions by defense acquisition executives take on substantially greater importance to both defense industries and the national industrial base.

With a reduced budget with which to procure new weapon systems, it appears as if the industrial base will have to rely, to a large degree, on the repair, overhaul, and modification/upgrade of existing systems to maintain some "warmth" in production capability.

My research, while far from exhaustive, has led me to conclude the following:

- The national defense industrial base is deteriorating at an alarming rate. This may seriously impair the ability of the economy to provide necessary logistics support for existing weapon systems during peacetime and, further, may hamper the economy's ability to provide

any reasonable surge in time of war.

-Program managers, indeed the entire DoD weapons acquisition bureaucracy, appear to be more interested in providing the most advanced systems to the operational user/customer. While this is critical to our national security interests, there needs to be a greater emphasis on and knowledge of the interrelationship of national security interests and the ability of the industrial sector to adequately provide for the requirements of the Defense Department in a severely declining defense market.

-There needs to be a greater level of cooperation between the government and private industry in providing depot-level support for weapon systems. While there may be a case to be made for maintaining a basic government owned/government operated depot organization, the fact is that no depot can technically, efficiently and cost effectively produce aircraft. That can only be done by prime contractors. However, those contractors can be expected to produce systems, especially in response to a surge requirement, if they have been allowed to maintain a level of production capability that can only come through depot-level maintenance.

1. OPNAVINST 5000.49A
2. MIL-STD-2080A(AS)
3. Ibid.
4. Gansler, Jacques S. Affording Defense. (MIT Press, 1991) p. 256
5. Charles B. Cochran, "DoD's New Acquisition Approach-Myth or Reality?" Program Manager, July-August 1992
6. Cheney, Dick, Secretary of Defense, Annual Report to the President and Congress. Washington: GPO, February 1992. 49
7. Ibid.
8. Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base U.S. Congress, Office of Technology Assessment. Washington: GPO, July 1991. 3
9. Ibid.
10. The Office of Technology Assessment provides five options for overhauling the current defense maintenance base. First, the defense maintenance base can be retained but undergo consolidation and restructuring. Second, it can increase use of the private sector. Third, it can increase competition among service organizations and private firms. Fourth, it can exploit new technology to provide maintenance upgrades. Fifth, it can provide maintenance upgrades to U.S. equipment abroad as well as foreign manufactured equipment. U.S. Congress, Office of Technology Assessment, Building Future Security, OTA-ISC-530 (Washington, DC: U.S. Government Printing Office, June 1992).
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